

The Singapore Botanic Gardens and Rubber in Malaya

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NATURAL RUBBER PRODUCTION in Malaya and other tropical Asian countries depends upon the cultivation of *Hevea brasiliensis*. This tree was introduced into the East and its exploitation developed through the agency of various botanical institutions and, as will be shown below, the part played by staff of the Singapore Botanic Gardens has proved exceptionally important.

The changing fortunes of the rubber producing industry have reflected the trends of world economic history during the first half of the twentieth century. Although during times of trade depression the plantation industry has done little more than provide a survival existence for its many employees, on balance natural rubber production has made one of the greatest contributions to prosperity in Malaya. This has been achieved in the first place by the attraction of capital and latterly because the industry has become the largest single source of employment and revenue in the Federation of Malaya. At present rubber plantation employees number over a quarter of million and it is estimated that nearly 400,000 smallholders are supported wholly or partly by rubber cultivation. Direct taxation of rubber exports has provided about 15 per cent of the total Federal revenue during the last five years. This figure was swelled by taxes on company profits and by other less direct means.

This enterprise, which has given a livelihood to a large section of the population representative of all races in Malaya and provided wealth for the country's development, owes its origin mainly to the Singapore Botanic Gardens.

The Introduction of Hevea to the East and Establishment in Malaya

The distribution of potential crop plants to enhance the utilisation of natural resources was a conspicuous feature of the work of the Royal Botanic Gardens, Kew, and its daughter institutes while Joseph Hooker was Director. He was knighted in 1877 and in 1897 honoured for his editorship of the Flora of British India.

Mr. James Collins had reviewed the rubber producing species of plants at the request of Sir Clements Markham of the India Office, the latter recommended the collection of *Hevea* from Brazil and its despatch to oriental territories, and Hooker implemented this recommendation.

Although several attempts were made under Hooker's guidance or by the India Office, only one—the famous Wickham collection—succeeded. The others failed either because the seed did not germinate or owing to the selection of unfavourable reception sites such as Calcutta and Sikkim where the plants died.

The success of the Wickham collection owed much to the expeditious handling of the material. Joseph Hooker commissioned Mr. H. A. Wickham (later Sir Henry) to collect seed, which he did in the area between the Tapajos and Madeira rivers of the Central Amazon basin. Wickham chartered a cargoless ship to rush his 70,000 seeds to England. At the expense of digression from the main theme the charge against Wickham of smuggling should be refuted here. Although he may have disbursed hospitality to speed official clearance of his perishable cargo, there is no evidence that he resorted to corrupt evasion of the law; in fact the shipment of seeds of *Hevea* from Brazil was not prohibited at that time and an official statement—*Borracha no Brasil*, Rio de Janeiro, 1913—reported that Wickham's and other exports were made with the goodwill and co-operation of the Brazilian government.

The seed reached Kew on 14th June, 1876 and Hooker ensured careful treatment; he obtained about 4 per cent germination, which was good considering the long journey and that it was unknown how the seed should be packed or treated. The bulk of the seedlings were despatched in Wardian cases (miniature greenhouses) to Ceylon, where extensive nurseries had been prepared at Henaratgoda on the orders of the India Office. Further shipments from Kew in 1876 were 18 plants to Java and 50 to Singapore, but the latter arrived at the Gardens in poor condition and the five survivors appear to have died subsequently. The following year 22 plants were sent from Kew to Singapore and successfully established by Mr. J. H. Murton, Superintendent of the Gardens.

The distribution of these plants is not fully known. Murton went plant collecting in Perak during October to December 1877, when he planted nine *Hevea* seedlings at Kuala Kangsar behind the old Residency on the bank of the Perak River. The Resident was Mr. (later Sir) Hugh Low, who, like Sir Stamford Raffles, was an active naturalist and very interested in economic botany. Murton is reported to have planted one of the 'Wickham' seedlings with other rubber bearing plants at Durian Sabatang. This may have been the

Durian Sabatang near Telok Anson, but his itinerary did not include Lower Perak unless he made an unrecorded call during the sea voyages between Singapore and Penang. He passed near the Durian Sabatang about twenty miles south of Matang and Taiping. Both these places together with Telok Anson have been quoted as sites for one or more of the first introductions, probably all referring to the single plant, which appears to have been soon lost for no traces could be found by Low in 1878. At least nine seedlings were retained at Singapore. The important point is that Murton established *Hevea brasiliensis* in two centres where the trees could be tended and observed, namely, at the Singapore Botanic Gardens and under Low's good care at Kuala Kangsar.

The plants at Singapore were multiplied to a limited extent by cuttings. However, Murton found, as has been confirmed repeatedly since, that only cuttings from young seedlings rooted easily. Thus there was a limit to the amount of material which could be propagated by this means. Nevertheless it is interesting and to Murton's credit that he was alive to the potentialities of the method and investigated its possibilities. The most suitable site was sought by Murton, his successor, Mr. N. Cantley and Mr. W. Fox, and, after two transplantings, the *Hevea* collection found a home in the newly acquired Economic Garden in 1879. Unfortunately the Government provided no funds for the upkeep of the Economic Garden and scrub invaded; thus by 1885 the trees were in a poor state of upkeep. The numbers were reinforced from 1884 onwards with the progeny of the originals and new imports from Ceylon. This was most important as these provided the material for the classic experiments by Ridley and Derry.

Meanwhile the trees at Kuala Kangsar had flowered in March 1880 and set seed the following year. Mr. (later Sir) Frank Swettenham, acting for Low in 1884, planted out about 200 seedlings on the banks of the Perak River and on the hill behind, where the new Residency was built. A group of seedlings was planted around the grave of British soldiers killed in the Perak expedition of 1876. These proved a valuable source of seed in later years.

The Search for a Means of Exploitation

The first tapping in Malaya was on the Kuala Kangsar trees by aborigines; they used an unsuccessful incision method probably similar to that employed to extract poisonous sap from the Ipoh tree. It is not clear when this was done, as some of the early literature is contradictory and includes evident typographic errors in the dates. Low is reported to have sent rubber samples to London

in 1884, which were not received favourably, but these may have been Ceara Scrap (from *Manihot glaziovii*, which was also planted at Kuala Kangsar); at any rate the confusion did not enhance the reputation of cultivated rubber. Swettenham may have directed an attempt in 1886 and—or—Low an attempt in 1888.

Another attempt was made in 1889 when Swettenham had succeeded Low and the results were again disappointing. Swettenham, having decided that there was no future for *Hevea* in Malaya, ordered the destruction of several of the original Kuala Kangsar trees and discouraged further interest. This remained the view in government circles for some years.

The year 1888 marked the arrival in Singapore of Mr. H. N. Ridley as Director of the Botanic Gardens. He shared Hooker's faith in natural rubber production by *Hevea* cultivation and, despite government opposition and lack of funds, set about rehabilitation of the Economic Gardens and experimented to find a practical means of extracting latex. As early as 1889, while Swettenham made his gloomy predictions, Ridley made his first basic discovery.

Hitherto virtually all forms of and attempts at tapping *Hevea* for latex were incision methods, by which a cut was made through the bark but no bark was removed. (We use bark here in the popular sense to denote all tissues outside the wood). Incisions tend to close, there is no proper channel for the trickle of latex to flow along into a receptacle and it is hard to judge the depth of the cut—the result is much wounding of the tree.

The *excision* method invented by Ridley involved removal of a paring of bark from the cut, which in the first place overcame the main defects of incision noted above, but lead to the further discovery that by repeated paring away of bark from the one cut at intervals a greater flow of latex could be stimulated. Rubber obtained by this method was exhibited at the Singapore Agricultural Exhibition in 1890 and samples were sent to London the next year, where they were pronounced excellent. Other members of the Gardens staff joined in the tapping experiments, C. Curtis in 1896 at Penang, L. Wray in 1897 at Taiping and R. Derry in 1898 at Kuala Kangsar, whence rubber was sold in 1899; the various botanic gardens in Malaya were then all under the direction of Singapore.

In 1904 Derry joined Ridley in Singapore and together they conducted a series of experiments, which established a number of principles and carried the technique far towards that currently employed. Mr. A. D. Machado and Mr. C. Boden Kloss assisted in the experiments and yield recording during some years. Only the main trends are described here to illustrate the progress made.

The first tapping was done with a pruning knife, chisel and mallet but these were superseded by a modified farrier's knife or gouge, a form of which was adopted on one of the first plantations—Jebong Estate—and the “Jebong” is still among the most useful tapping implements. The advantage of morning over afternoon tapping was first established at Singapore. The relative performance of wide- and close-planted trees was investigated; the conclusion was reached that a relatively wide spacing giving a stand of 150 trees per acre would give more economic tapping and a longer useful life than much denser plantings.

The arrangement of the cuts fell into two patterns: (i) herring bones, in which sloping lateral cuts branched upwards from a central vertical channel and (ii) spirals encircling the tree several times. The Singapore workers soon abandoned the more fanciful systems, and although they do not seem to have reached the ultimate simplifications, i.e. neither reduction of a double fishbone to a single V-cut and of a half fishbone to a single half spiral, nor restriction of the number of turns in a helical cut to one full or half circumference cut as now, their conclusions were moving in that direction.

At first there was much apprehension that if tapping were continued too long, the bark would not renew over the ever extending area of excision. Ridley and Derry grew bolder as their experience confirmed that continuous tapping—indefinitely repeated excision at regular intervals—was possible, the bark renewed and moreover greater yields were induced. The simplification of the original herring bone was largely to allow adequate time (four years was at first thought sufficient) for bark renewal before one cut encroached on the next under continuous tapping. They compared daily and alternate daily tapping and expressed a preference for the latter.

Changing Interests and the First Plantations

The tapping experiments described above continued until 1909 and we must revert to the period immediately after Ridley's discovery of a practical method of exploitation to carry on the general history of the subject. The depredations of disease were rapidly making coffee cultivation uneconomic and the owner-managers of the first estates were looking for alternative crops. At first Ridley was still a voice crying in the wilderness as far as rubber was concerned, some of his critics referring to him openly as ‘mad’ Ridley. Although some planters such as Mr. Hislop Hill and the Kindersley brothers continued to plant scattered trees of *Hevea* for observation and to provide seed should the crop realise its potentialities,

the first plantation development was the planting of 40 acres of *Hevea* by Mr. Tan Chay Yan at Bukit Lintang. There is some confusion about the date of this. Ridley has stated 1896 but some later authors quote 1898. One of the Kindersley ventures in 1895 is reputed to have been virtually a plantation of *Hevea*. Mr. Tan exhibited rubber in 1898, presumably prepared from his older parent trees and not from the 40-acre block. At any rate this was the turning point; there had been little interest before but now Mr. Tan went ahead with a larger planting at Bukit Asahan and many other planters followed suit.

The decline of coffee cultivation, the increasing demand for and price of rubber on the world market were important factors: nevertheless Ridley's discovery of excision tapping and persistent propaganda were essential contributions.

We must note here that Murton's choice of two sites, Singapore and Kuala Kangsar, for the first introductions had several important results relating to the rapid expansion of plantations. Mr. Cross, who made an unsuccessful shipment of seed from Brazil to the East, had stated that damp, swamp soils were the best for *Hevea*, especially land subject to flooding. Wickham had in fact collected his seed from an undulating plateau probably with a well drained soil, which he confirmed in 1902. However, unsuitable water-logged sites would probably have been chosen for many years if Murton had not established the Kuala Kangsar trees on what would now be recognised as a typical soil for *Hevea*, i.e. moist but well-drained. Thus the range and suitability of habitats for *Hevea* in Malaya was demonstrated by this and subsequent early plantings at Kuala Kangsar, Taiping and elsewhere by Low, Swettenham and Hill.

Furthermore these trees provided a local source of seed for North Malaya, some of which were planted by Hill in Negri Sembilan, and in 1893 he had seed available in quantity. Seed was despatched to the many new plantations in Malaya and other territories; Ridley had found that the best packing for long distance travel was damp charcoal in sealed biscuit tins.

Research and Advice

The new development raised many problems, first in cultivation and later in processing of the crop—in other words there was a need for research and advice. This had been anticipated by Ridley and his assistants, who had devised means of coagulating latex for shipment and studied conditions of tree growth and many diseased specimens.

As early as 1891 the first Agricultural Bulletin had been published; but owing to lack of funds and delays at the Government Printing Office this did not appear regularly until 1901. When Ridley was preparing to depart in 1911 and it appeared that publication might cease, the Planters' Association of Malaya pleaded that his successor should continue it, remarking that 'Ridley's contributions have been highly valued by the Planting Community and it would be a distinct loss if the Bulletin were discontinued.' Feeling towards 'mad' Ridley and the other rubber enthusiasts among his colleagues had changed considerably over twenty years. When leaving Malaya Ridley left pleas in the Agricultural Bulletin and Greniers Rubber News for an expansion of research and advisory services.

By this time the Department of Agriculture F.M.S. (founded 1905) had assumed responsibility for investigations on rubber, although there had been a transition period during which the experience and current experiments of the Gardens' staff were available until the new Agricultural staff were conversant with the problems. For instance the Singapore Botanic Gardens was for many years among the few institutions with an adequate number of trees in tapping for experiments on the preparation of rubber from latex; Ridley had made the first 'biscuits' of rubber coagulated in shallow plates and Derry continued for many years to make improvements in processing, including coagulation, sheet and crepe manufacture.

We will review here only the contributions made by the Gardens' staff—in particular Ridley's. There was activity along parallel lines elsewhere, particularly in Ceylon and Java, the importance of which we do not wish to ignore or gainsay; moreover the Gardens enjoyed the collaboration of Mr. P. J. Burgess, the Government Analyst, who made several contributions on tapping, coagulation and processing. Nevertheless the extent of activities and number of first records by the Gardens' Staff adequately illustrate their pre-eminence in this field.

Pests and diseases are always among of the first difficulties encountered in new crop culture. Termites were the first insects to trouble *Hevea* in Malaya; apart from 'plantation hygiene'—which was only partly helpful—Ridley was unable to solve this problem. However, the full control of termites has had to await the discovery of modern insecticides. Crickets and mites appeared in due course; for the latter Ridley and Derry recommended sulphur dusting.

The white and brown root diseases of rubber were first described in 1904 and 1909, respectively, by Ridley who advocated detection

and destruction of sources of infection. He reported on 'pink' disease of the stem and branches in 1905 and advised destruction of diseased tissue and treatment with copper sulphate and lime. Birds eye spot was recorded as an ephemeral disease of young seedlings in 1906. The present-day planter will be struck by the small changes in the principles of disease control recommended today and those suggested by Ridley.

The first report on the deleterious effects of applying lime to *Hevea* was made by Ridley in 1903, when he conducted a manurial trial.

Prophecies and Warnings

The early planters were, almost without exception, keen advocates of clean weeding; the majority would not tolerate any catch crop which might deter from the main crop nor any cover crop for soil protection. During the first decade of the century many planters had adopted the practice of eradicating all plant growth by spraying sodium arsenite repeatedly. Ridley saw further and especially in his last editorials addressed serious warnings on the risks of soil erosion to the plantation managers. He suggested chillis, pineapples, bananas and bowstring hemp (an agave) as possible catch crops, which—except the last—can all be seen put to good use on small properties today especially by Chinese. Tapioca, the catch crop favoured by the minority group of 'maximum exploitation—minimum time and effort' planters, was considered by Ridley to be liable to exhaust the soil and to spread root disease; therefore he advised caution and experiment before using tapioca as a catch crop, which attitude has been amply justified. In 1910 Ridley prophesied that contour terraces would be necessary to control erosion on slopes and that cover crops such as the local wild *Crotalaria* would be needed for soil protection and enrichment. He realised that not all lands were suitable for rubber cultivation and condemned planting *Hevea* on deep peat soils.

We note too that Ridley advised against cutting out coconuts in order to plant rubber, stating explicitly that neither individual estates nor the country should rely exclusively upon one crop. He was one of the first to suggest the oil palm as a plantation crop and distributed over 3,000 seeds.

There have been and there are—as there should be—critics of the unbalanced state of Malayan agriculture, meaning in particular the predominance of and dependence on rubber. Critics of the plantation industry have pointed to clean weeding and other bad practices of the early planters, whose rapacious exploitation of the

soil has bequeathed us many problems in its rehabilitation. Nevertheless, these critics should realise that the practical founder and advocate of the rubber plantation industry—Ridley—warned against these errors; indeed the slump of 1913 came as an early reminder of the risks involved in dependence on one crop, but neither the sound business men nor officialdom took much heed. Ridley was ably assisted and—perhaps to greater extent than we realise—guided by a team of Gardens' staff in Singapore and throughout Malaya, who were all devoted to the study of plants and fully appreciative of their value in preserving and developing the resources of the land they had come to serve.

We come now to the close of the period during which the Singapore Botanic Gardens were directly responsible for the development of the rubber industry in Malaya. Mr. I. H. Burkill became Director in succession to Ridley in 1912. Rubber development had then become entirely the responsibility of the Department of Agriculture. Yet Burkill maintained tapping of the *Hevea* at Singapore and yield recording of the individual trees, so that the most productive could be selected as seed parents for future improvement of planting material.

The Present Situation

In 1926 the Rubber Research Institute of Malaya was created by enactment and in turn took over responsibility for rubber. The Botanic Gardens have continued with the basic studies of systematic research into the Malayan flora and the nature of the vegetational formations in the region. It might seem that we have gone our separate paths and the Botanic Gardens are of no further service to the rubber industry, but such a view ignores one of the greatest problems still lacking a solution. We need the help of the fundamental botanist, who is found in institutions such as the Botanic Gardens, which we wish well—not for sentimental reasons because of the great contributions of the past—but in expectation of further assistance in the future.

Malaya and most of the other countries where *Hevea* is cultivated lie in the region of the tropical rain forest. This type of vegetation is very complex; frequently over one hundred different tree species are found in a single acre of Malayan jungle with even more species amongst the epiphytes, lianes and ground flora. The rain forest has developed and perpetuated itself for millenia, but the whole formation is now rapidly disappearing under the pressure of man's advance before he has discovered how it functions.

This state of affairs has been frequently acknowledged recently, for instance at the Ninth Pacific Science Congress, Bangkok, 1957, at the Centenary and Bicentenary Congress, University of Malaya, Singapore, 1958, and at the UNESCO Symposium on Humid Tropics Vegetation, Bogor, 1958. Every appreciation of the situation emphasises that the effects of rain and insolation on exposed tropical soils can lead to rapid impoverishment and erosion. Phosphate availability in most Malayan soils is notoriously low and other nutrients are easily leached out of disturbed soil; there are indications that these can be alleviated or prevented by a suitable vegetational cover which maintains the organic content of the top soil. Such vegetation controls physical erosion and through its many members circulates nutrients also.

Copious rainfall, constant warmth and generous irradiation with sunlight are all factors which contribute both to rapid plant growth and to rapid soil degradation. The success of the tropical rain forest derives from its ability to use the benefits of these factors to provide a luxuriant vegetation on generally poor soils, despite the deleterious potentialities due to these same factors. The object of agriculture in the tropics is to produce a luxuriant crop without soil degradation.

Although the agriculturalist can apply fertilisers to make good losses and deficiencies and can use physical means such as terraces and water channels to control erosion and water distribution, basically he has to solve the same problems which the forest has surmounted. This will probably be achieved most effectively and economically by the same means as those which are successful in nature; it is unlikely that totally different principles will succeed where we must contend with tropical climate, poor soil and undulating terrain.

A single crop culture, even in association with a cover crop which is often limited to a narrow spectrum in floristic composition and growth form, is unlikely to perform all the functions carried out by the natural forest vegetation. Plantation crops such as rubber will continue to be grown in stands of one crop because this enables more economic cultivation and harvesting. Nevertheless there is a need to enrich the ecological association of these crops by introducing into the cover further elements which can fulfil the processes of soil conservation. Currently we are approaching this problem by growing various plants in association with the main crop and endeavouring to assess their effects upon the main crop and upon the soil. However, we would be better guided in our choice of plants and factors to study if we knew how the natural tropical rain forest functions.

The Future

It is often stated that the future of the natural rubber industry depends upon reducing the cost of production; nevertheless if the existing advances, especially in the selection of planting material of improved yield, are exploited fully, as is attempted in the current replanting programme, a production cost competitive with synthetic rubber can be achieved. Further research will be necessary to keep the cost of production down to this level despite rising wage trends and possible cheaper synthetic production. In the preceding section we envisaged an ideal tropical agriculture harnessing the natural processes of the forest; such a system for rubber cultivation would doubtless form a valuable contribution towards the long term reduction of production costs, but would moreover preserve the fundamental asset—the soil itself. Investigations on the functioning of the tropical rain forest have scarcely been essayed, yet this is a most important field both for its scientific interest and in order to evolve a rational form of agriculture for land utilisation in the tropics. The scientific manpower available is limited but the destruction of the forest is continuing apace. No one institute can tackle this problem alone, because the facilities built up over long periods such as herbaria, experimental gardens and forest reserves of known history and laboratories proper to different institutes are all needed. Moreover scientists trained in various disciplines who have experience in institutes devoted to every branch must co-operate in this undertaking.

The Departments of Forestry and Agriculture in the Federation of Malaya are daughters of the Singapore Botanic Gardens and the Rubber Research Institute is in effect a grandchild. Within this family there is scope to tackle the fundamental problems of tropical ecology; may the centenary of the Singapore Botanic Gardens be marked by revived interest in this subject. The difficulties which we have inherited and the problems we may bequeath owing to poor land management will be best solved and prevented by this means.

References

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- (2) *Journal of Heredity*, Vol. XIX, p. 193, 204 and 485. 1928.

(3) Various articles in:—

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(b) *Agricultural Bulletin of the Straits and F.M.S.*, Vols. I to X. Singapore, 1901–1911.

An index to these publications, including articles on research and advice on *Hevea* cultivation, will be found in:—*Gardens Bulletin S.S.*, Vol. I, p. 48. Singapore, 1912 (which was originally published as *Agric. Bull. S. & F.M.S. Third Series*, Vol. I. 1912).

(4) *Gardens Bulletin S.S.*, Vol. I, p. 247. Singapore, 1912. Biographical notes on botanists resident in Malaya, including the itinerary of Mr. H. J. Murton's journey, may be found in:—

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The climate of opinion among early planters may be judged from minutes of their meetings given in the *Agricultural Bulletin*, also by the correspondence and reports in *Grenier's Rubber News*, Kuala Lumpur, 1909 et seq.

The proceedings, when published, of the undermentioned may be consulted for accounts of the significance of the tropical rain forest in land utilisation today.

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